peculiar manner in which they lend themselves to subdivision or multiple expansion is examined, it will be seen that they are inseparably connected with circles which have their radii related in the manner described. Study of these figures will enable one to tell, by merely looking at a proportioned object, the order of its symmetry or character of its plan. For instance, in a cross-section of the young fruit and contained seeds of the verbena, certain circles are involved in relationship to a square. Without making any measurements from the fruit, the plan can be accurately formulated (Fig. 1).

This construction is simple, but it involves principles which are far-reaching. The ground plan of the Parthenon is an instance of architectural construction where the detail is co-ordinated in much the same manner.

The basal projection of the crystal of topaz (Fig. 2) involves all the proportions which occur in regular forms. There are the primary circles the radii of which form the geometrical progression with the binary ratio, and the secondary circles as derived from the sides of the equilateral triangle, the square and the regular pentagon. This example also includes the odd proportion derived from the perpendicular of an equilateral triangle. This

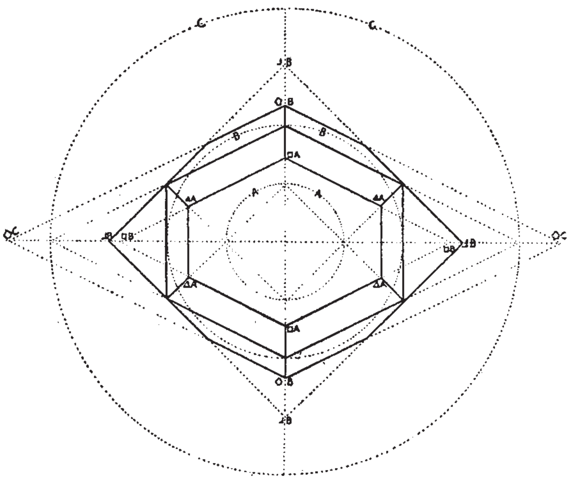

FIG. 2.—Crystal of topaz—basal projection.

A A Primary circle 1.
B B „ „ 2.
C C „ „ 3.
Distance of point □ A from centre determined by □ in A.
„ „ △ A „ „ „ △ in A.
„ „ B „ „ „ in B.
„ „ □ B „ „ „ □ in B.
„ „ ⅃ B „ „ „ ⅃ in B.
„ „ ⬠ C „ „ „ ⬠ in C.

This crystal base contains the entire scheme of proportion and symmetry as found in the Parthenon.

is the only proportion found in symmetrical natural form which seems to be connected with an arithmetical progression.

The Greek and Gothic styles of architecture furnish the most satisfactory results in a comparison of their curves and proportions with the curves and proportions of natural symmetrical forms. In the finest example of the former, the Parthenon, the agreement is so extraordinary that all its proportions and curves may be obtained with no other instrument than a string and a couple of sticks. A surface of levelled earth would furnish a place to make the simple constructions. The beautiful curves found in this building, which so simulate those of conic sections as to deceive the expert mathematician, can be accounted for by this method. In fact, there is no curve in Greek formal art which may not be simply, rapidly and accurately drawn with a compass, and when so drawn, the circles used will be found to possess a definite relationship one to the other. This method would seem to furnish a simple explanation as to how the Greek architects used these curves so long before their supposed discovery. The agreement between the plans of the regular forms of Nature and the plans of the best buildings would seem to suggest that the great architects possessed a formulated or intuitive knowledge of simple principles of proportion which are unknown to us.

[1] ⅃ is the symbol for the perpendicular of the equilateral triangle.

EARTHQUAKES AND EARTH PHYSICS.

PROF. J. MILNE, F.R.S., read a paper on "World-shaking Earthquakes" before the Royal Geographical Society on November 11. In the course of his paper, he remarked that earthquakes may be divided into two groups—first, those which disturbed continental areas, or even the world as a whole, which he called macroseismic, and, secondly, local earthquakes disturbing a few miles' radius, or not more than 100 or 200 miles, which he called microseismic. Evidence of the existence of large earthquakes was sometimes afforded, even though they could not be felt; for example, in 1755, the motion of the water in lakes and ponds observed in England, Scandinavia and North America was attributed to the earthquake at Lisbon. Another form of evidence was sometimes discovered by astronomers, as in May, 1877, M. Nyrén observed disturbances in the level of the axis of the transit at Pulkova, which were held to be due to an earthquake about an hour and a quarter earlier at Iquique. The first instrumental record obtained by the writer of an earthquake which could not be felt was in March, 1884. This and others were referred to as "slow earthquakes." A long series of observations justified him in saying, in 1883, that every large earthquake might be recorded at any point on the land surface of the globe. Thus a new field was open to seismologists, and recording stations were now to be found in many countries, the most complete organisation working in connection with a committee of the British Association. A large earthquake seemed to propagate a series of waves in all directions through and in all directions over the world's surface. Describing in detail the character of this motion, he said that the large waves of earthquakes seemed to pass beneath a country like ours with the character of an ocean swell. The character of these waves was still in process of investigation, and there were reasons for and against any conclusions which might be reached. It would appear that the effective rigidity of the world was about twice that of steel, and it was easy to measure the difference in time between the arrival of preliminary tremors and of large waves—the former reaching a place 80° from their origin in about fifteen minutes, whilst large waves took about fifty minutes. From these differences in times of arrival of different waves, distances of origins could be obtained, and from the distance ascertained from several distant stations the origin might be easily located. Another method of ascertaining origin was the difference of the times of arrival at different stations of large waves, and by these methods the origin of the world-shaking earthquakes for 1899, 1900 and 1901 had been determined. Prof. Milne established a relationship between the distribution of the origins of large earthquakes and the pronounced irregularities of the surface of the earth by a number of illustrations taken from the Alaskan region, which had yielded large seismograms to the Cape of Good Hope, which was antipodean to Alaska, the Cordillerean region, the Antilles, the Andes, Japan, and other parts of the world. He also gave an historic account, dating from 1692, of the mass displacements which had been caused by great earthquakes. As examples, in 1855, in New Zealand, 4600 square miles were raised 1 foot to 9 feet; and in 1897, in Assam, according to Mr. R. D. Oldham, 10,000 square miles of country were displaced possibly 16 feet along a thrust plane.

The connection between large earthquakes and volcanic activity was considered; and instances were given of the seismic convulsions which apparently resulted in reliefs of volcanic strain. So recently as the early part of last summer, the symptoms of volcanic and seismic activities in the Western Hemisphere culminated in the terrible explosions in Martinique and St. Vincent. Prof. Milne also gave the result of inquiries into the relationship between world-shaking earthquakes and unusual movements of magnetic needles. At certain stations, the unfelt waves of large earthquakes disturb magnetic needles, but this is not the case at all stations. This difference in behaviour is not explicable on the assumption that the movements are due to tilting of the instruments, but it is possible that they may be due to magnetic influences. The stations at which movements are observed, Prof. Milne suggests, may be nearer to the magma in which the large waves are propagated than the other stations where movements are not observed. Inasmuch as this magma is not only magnetic, but is also dense at the former stations, the observed value for g would exceed that at the remaining stations, *caeteris paribus*. In support of this view, figures were adduced. References were made to small changes in latitude. When

these were pronounced, world-shaking earthquakes had been frequent. A comparison of the varying number at different periods of small earthquakes showed that the number recorded increased; but this was evidence, not of the growth of seismic activity, but of more general observation. Nearly all large earthquakes were followed by a long series of after-shocks. For example, after the disturbance of October 28, 1901, which had its origin in Central Japan and which might be regarded as a typical world-shaking earthquake, during the first twelve months, 2956 shocks were noted. Next year the number fell to 391. The conclusion seemed to be that in any given year there were 27,500 shocks which could be recorded in epifocal districts, and that, on the average, there annually were 30,000 small earthquakes. From seismograms obtained in epifocal areas, measures of earthquake energy had been obtained. The result was that engineers and builders were now able to build to withstand known forces, and in Japan, in particular, effectual methods had been adopted to resist the severe shakings to which that country was subject. The Japanese Government had so far recognised the importance of seismology as to establish professorships to encourage its study.

THE ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW.

NOT many scientific societies of the kingdom can boast of having existed for a hundred years, but the Royal Society of Edinburgh a few years ago celebrated its centenary, and last week what is now known as the Royal Philosophical Society of Glasgow was engaged in celebrating the attainment of its hundredth year, for it came into being on November 9, 1802, with sixty-two of the most prominent men in the city as members, many of whom have since acquired prosperity and reputation. There was Dr. William Meikleham, the professor of astronomy and natural philosophy in the University, and who was Lord Kelvin's predecessor in the natural philosophy chair, so that those two men practically covered the century between them. There was also Dr. George Birkbeck, subsequently a professor in the "Andersonian," and the founder (in London) of mechanics' institutions. Patrick Cumin, another foundation member, was the professor of Oriental languages. A particularly notable man in the membership was David Mushet, the discoverer of the famous blackband ironstone which did so much to make Scotland the leading element in the creation of the iron industry. Among other original members were Charles Macintosh, who originated the "macintosh" as an article of clothing for wet weather; Mr. John Roberton, a famous iron-founder, who read many papers in subsequent years; and Mr. William Dunn, of Duntocher, a well-known machine-maker. Mr. James Boaz was an accountant; he took a warm interest in the Society, and became secretary in the year 1804, remaining in that office to the great credit of the Society for twenty-six years. Sundry other original members might be named and descanted upon, men from the very highest ranks, and who collectively made Glasgow or contributed very materially towards it, but we must refrain from doing so. Worthy John Geddes, of Verreville, glass manufacturer and potter, was an early member, and he was the second president. The Society did not publish any *Proceedings* or *Transactions* until the year 1844, after Dr. Thomas Thomson, F.R.S., had become president. That gentleman was the famous professor of chemistry in the University, and his knowledge was frequently called forth during the eighteen years that he held the office of president. Mr. Walter Crum, F.R.S., famous as a scientific calico printer, succeeded Dr. Thomson in the chair, and then there was a somewhat continuous run of University presidents, such as Dr. Allen Thomson, F.R.S., Prof. Wm. Thomson, F.R.S. (now Lord Kelvin), Prof. Thomas Anderson (distinguished as a chemist), Prof. W. J. Macquorn Rankine, C.E., F.R.S., and Prof. Henry D. Rogers (American geologist). After he had been knighted, the professor of natural philosophy was again made president for the years 1874-75-76-77. The Society was always in a position to command the services of able and learned men to take the presidential chair, and business men have always been in abundance to fill the executive offices and to discharge the duties pertaining to them for periods extending from six years (in the case of Prof. McKendrick as secretary) to upwards of thirty years, as in the case of Mr. John Mann, the present treasurer.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An Isaac Newton studentship in physical astronomy and optics, of the value of 200*l*. a year for three years, will be awarded in the Lent term, 1903. Candidates must be Bachelors of Arts who are under twenty-five years of age on January 1, 1903.

IT is announced that a chair of tropical medicine has been founded in University College, Liverpool, with an endowment of 10,000*l*. Major Ronald Ross, C.B., F.R.S., has been elected to the chair.

SIR OLIVER LODGE, F.R.S., was on November 14 entertained at the annual dinner of the Liverpool Philomathic Society, when he delivered an address. He said his removal to Birmingham was solely because of the greater opportunity for his own work which his position in that city afforded him. Speaking of universities, he remarked that the competition among cities to make themselves worthy to become the seat of a university was healthy and holy, and he trusted the movement for establishing a university for Liverpool was gaining ground.

THE second subsection of Clause 18 of the Education Bill, as amended in Committee of the House of Commons on Friday last, lays it down that "the power to provide instruction under the Elementary Education Acts, 1870 to 1900, shall, except where those Acts expressly provide to the contrary, be limited to the provision of instruction given under the regulations of the Board of Education to scholars of not more than fifteen years of age in a public elementary school, but any scholar may remain in such a school to the close of the school year in which he or she reaches the age of fifteen." The difficulty which has existed for some time of defining what constitutes elementary education is thus in a large measure disposed of. An attempt was made to remove the age limit and so allow it to be possible for a child to stay at an elementary school so long as the parents wished. But the intention of the Government appears to be to encourage the drafting of children of capacity into secondary schools, and in this way to reduce expense and also prevent overlapping.

AT the invitation of the University of Cambridge, representatives of all the universities of England and Wales, of the numerous educational associations concerned with secondary education, as well as of the Board of Education, assembled in the Senate House at Cambridge on November 14 and 15 to confer as to the training of teachers in secondary schools for boys. Among men of science who took part in the interesting debates, following the papers on different subjects requiring consideration, were Prof. H. E. Armstrong, F.R.S., Sir Oliver Lodge, F.R.S., Prof. John Perry, F.R.S., and Sir Arthur Rücker, F.R.S. The Vice-Chancellor of the University presided at both meetings, and among the papers, those of Sir Richard Jebb, Mr. Sidgwick and the Master of Marlborough were of particular importance. As Sir John Gorst, whose speech concluded the proceedings, pointed out, if the universities intend to remain at the head of this movement for obtaining suitable training for the masters in secondary schools, they must be progressive and make use of the best of the methods which experience has shown to be suitable to the new demands. One such method, he pointed out, is that by which science is studied by research carried on by the pupils.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, November 13.—Dr. E. W. Hobson, president, in the chair.—The De Morgan medal for 1902 was presented to Prof. A. G. Greenhill.—Mr. Tucker having retired from the office of secretary, the following resolution was proposed by Dr. Hobson, seconded by Dr. Glaisher, and carried unanimously:—"That the thanks of the London Mathematical Society be offered to Mr. Robert Tucker for the eminent services which he has rendered to the Society during the thirty-five years in which he has held the office of honorary secretary."—The council and officers for the ensuing session were elected. They are as follows:—President, Prof. Lamb; vice-presidents, Mr. Tucker, Dr. Hobson, Dr. Baker; treasurer, Dr. Larmor; secretaries, Prof. Love and Prof. Burnside; other members of